Can Scientific Development and Children's Cognitive Development Be the Same Process?*

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In this paper I assess Gopnik and Meltzoff's developmental psychology of science as a contribution to the understanding of scientific development. I focus on two specific aspects of Gopnik and Meltzoff's approach: the relation between their views and recapitulationist views of ontogeny and phylogeny in biology, and their overall conception of cognition as a set of veridical processes. First, I discuss several issues that arise from their appeal to evolutionary biology, focusing specifically on the role of distinctions between ontogeny and phylogeny when appealing to biology for theoretical support. Second, I argue that to presuppose that cognition is veridical or "truth-tropic" can compromise attempts to understand scientific cognition both throughout history and in the present. Finally, I briefly sketch an evolutionary approach to understanding scientific development that contrasts with Gopnik and Meltzoff's.

1. Introduction. In the last fifteen years philosophy of science has been transformed by the influence of the cognitive sciences. Psychologists and other cognitive scientists offer methods and approaches that they believe will help address traditional problems in philosophy of science. Many philosophers welcome the interest and embrace the cognitive science approach (Giere 1988, Churchland 1989, Thagard 1988). The approach is often referred to as cognitive science of science. Recently,

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developmental cognitive psychologists have offered their expertise in understanding scientific development. An adventurous defense of the developmental psychology approach to understanding science is presented in a book by Alison Gopnik and Andrew Meltzoff (1997; henceforth GM) and in various papers by Gopnik (1996a, b, c).

My aim in this paper is to assess Gopnik and Meltzoff's developmental psychology of science as a contribution to the understanding of scientific development. I do not present a comprehensive critique of Gopnik and Meltzoff below as many aspects of Gopnik's views have been criticized recently.[1] Here I focus on just two specific aspects of Gopnik and Meltzoff's approach: the relation between their views and recapitulationist views of ontogeny and phylogeny in biology, and their overall conception of cognition as a set of veridical processes. First, I discuss several interesting issues that arise from their appeal to evolutionary biology. I focus specifically on the role of distinctions between ontogeny and phylogeny when appealing to biology for theoretical support. Second, I argue that presupposing cognition is veridical or "truth-tropic" can compromise attempts to understand scientific cognition both throughout history and in the present. This argument is made in two parts: the first examines an example from the history of science and the second discusses the role of truth in evolutionary accounts of cognition. I also briefly sketch an alternative approach to understanding scientific development that contrasts with Gopnik and Meltzoff's. Although my approach is at odds with Gopnik and Meltzoff's in some specific respects, I share several of their concerns about currently existing accounts of scientific development and I endorse some of their methodological directives. Specifically, I endorse their proposals to give precedence to individual scientist's cognition and to present a type of evolutionary account of scientific development. Throughout, I illustrate the extent to which cognitive scientists who present revisions to philosophy of science share some key assumptions with mainstream philosophers of science. Empirical investigations in the cognitive sciences may force us to reconsider these key assumptions.

2. Developmental Psychology of Science: A Summary of the View. Gopnik and Meltzoff's view is that the processes underlying cognitive development in children and scientific development are similar or even identical. This is the case because both developmental processes involve

1. For example, Miriam Solomon (1996) criticizes Gopnik's views on the social nature of scientific practice; Arthur Fine (1996) focuses on her naive realism; and Stephen Stich and Shaun Nichols (1998) present a wide range of criticisms of Gopnik and Meltzoff's book.

theory change: one theory is replaced by another largely due to overwhelming evidence against the older theory and for the newer one. They refer to this view as the theory theory:

> The central idea of this theory is that the processes of cognitive development in children are similar to, perhaps even identical with, the processes of cognitive development in scientists. Scientific theory change is, after all, one of the clearest examples we know of the derivation of genuinely new abstract and complex representations of the world from experience. The model of scientific change might begin to lead to answers to the developmental questions. . . . (GM, 3)

Many readers will find this definition of the theory theory unfamiliar. The theory theory is usually referred to in debates over what representations underlie our common sense folk psychology (see, e.g., Carruthers and Smith 1996). In this literature, the theory theory is the view that underlying our folk psychology is a kind of theory. A similar claim is made about our folk physics, our everyday inferences about middle-size objects, which depend on a kind of theory. Neither of these underlying theories need be much like scientific theories; they have been variously described as coherent sets of beliefs or sets of beliefs that ground predictions (Stich 1983; also cf. Churchland 1988).

Stich and Nichols (1998) have a felicitous phrase for Gopnik and Meltzoff's view, they call it the "theory theory to the max." Gopnik and Meltzoff hold that the theories underlying children's understanding of minds and everyday objects are just like scientific theories. Gopnik (1996c) has a less exciting name for the view, the theory-formation theory. I will use her terminology throughout so as to dissociate her view from that of milder theory theory proponents.

Scientists and philosophers of science have reached no consensus over just exactly what scientific theories are and Gopnik and Meltzoff acknowledge this point. As a result they propose an account of theories that is as "mainstream and middle-of-the-road as possible." Their main aim is to present theories as "direct candidates for psychologically real representations and rules" (GM, 33). As a result they are not inclined to consider philosophical debates over the nature of theories. They claim that such philosophical debates are largely beside the point concerning issues of logic rather than psychology.[2]

Gopnik and Meltzoff share the rejection of entirely logically-oriented approaches to theories with many contemporary philosophers of science. This is not surprising as the move was initiated among philosophers as a result of interest in cognitive psychology. Ron Giere

2. This is a debatable point that I do not take up here.

(1988) and Philip Kitcher (1993) present alternative views of scientific theories that are intended to be more psychologically realistic. What Gopnik and Meltzoff argue they add to these approaches is an emphasis on the "dynamic" aspects of theories such as theory change and theory formation. But much of the story they present here is also familiar in philosophy of science. On Gopnik and Meltzoff's account, theories are confronted with counterevidence; theorists initially ignore this; the counterevidence mounts and a new theory that copes better with the evidence supersedes the original theory. Their interesting move, that departs from most contemporary philosophy of science, is that this familiar presentation of the dynamic features of scientific theories also characterizes cognitive development in children. On this view, very young children, even 42-minute-old babies, have theories that they revise in the face of new evidence, base experiments on, and subsequently reject in favor of new theories.

Before turning to the discussion of the theory-formation theory, I should lay out Gopnik and Meltzoff's conception of cognition, because it is crucial for an understanding of their overall views on scientific development. Their view is that "cognition is about how minds arrive at veridical conceptions of the world" (GM, 15). And further:

> The assumption of cognitive science is that human beings are endowed by evolution with a wide variety of devices—some quite substantive and domain-specific, others much more general and multi-purpose—that enable us to arrive at a roughly veridical view of the world. Usually in cognitive science we think of these devices in terms of representations of the world and rules that operate on those representations. (GM, 15)

This view is put more starkly by Gopnik as follows: "A cognitive scientist would say that evolution constructed truth-finding cognitive processes" (1996a, 489). Now we can see the connection between cognition and science:

> Science employs a particularly powerful and flexible set of these cognitive abilities. Science uses a set of representations and rules that are particularly well-suited to uncovering the truth about the world. Science gets it right because it uses psychological devices that were designed by evolution precisely to get things right. (1996a, 489)

This view of cognition and science can now be tied in with the story about cognitive development. The theory-formation theory proposes that the cognitive processes in science are similar to those that guide children's development because these processes were designed by evolution "to allow human children to learn." Science and human babies both use the same truth-gaining processes. In the following two sections I discuss some aspects of this view in more detail.

3. Ontogenetic and Phylogenetic Theories of Development. In this section I provide some definitions. In biology, ontogeny is "the life history of an individual, both embryonic and post-natal" (Gould 1977, 483) and phylogeny is "the evolutionary history of a lineage, conventionally (though not ideally) depicted as a sequence of adult stages" (Gould, 484). Biologists provide very different accounts of ontogenetic and phylogenetic development. One issue that, even otherwise warring, biologists agree upon is that many relations between ontogeny and phylogeny are still mysterious.

In the nineteenth century, many biologists believed that ontogeny recapitulates phylogeny—individual organismal development passes through the stages of the phylogenetic history of the organism—and Haeckel, the most famous proponent of this view, held that one underlying mechanism explained both processes (Gould 1977, 78). Now it is largely agreed that phylogeny is accounted for by the random processes of mutation and recombination, which produce variation, which is in turn acted upon by selection. The standard micro-evolutionary explanation also includes genetic drift and other factors.[3] Ontogeny is accounted for by the immensely complex interactions of genes, organism, and environment that contribute to the development of individual organisms. Although there is a great deal of progress in evolutionary developmental biology, there is no standard picture such as the micro-evolutionary model. One thing is agreed upon: recapitulationism is false.

4. Ontogeny and Phylogeny in Scientific Development. Gopnik and Meltzoff's theory-formation theory refers to three developmental processes: children's cognitive development, scientists' cognitive development, and the development of science. Let me first clarify why I believe these three are separable. Scientists and science are not the same. Science has a history that consists of the practices and achievements of scientists. So scientific development is not the same as scientists' development. Prima facie, children and scientists are likely to have different cognitive processes.[4] Once we grant these processes are separa-

3. This is an oversimplification even of the standard story. For the purposes of this paper I simply assume that microbiology unambiguously accounts for macrobiological phenomena such as phylogeny. For this view see Futuyma 1986; for a more developmentally oriented view see Gerhart and Kirschner 1997.

4. Gopnik and Meltzoff provide a good discussion of why we should resist this prima facie judgment. I tackle this issue briefly below.

ble, there are several relations that could hold between them. Gopnik and Meltzoff suggest that all of the following relations hold at different places throughout their work. The theses that express these relations do explanatory work for Gopnik and Meltzoff and are as follows:

- (a) Children's development is identical to scientific development.
- (a′) Children's development is similar to scientific development.
- (b) Children's development is identical to scientists' development.
- (b′) Children's development is similar to scientists' development.
- (c) Scientific development is a model for children's development.
- (d) Scientific development is analogous with children's development.
- (e) Science and children use the same cognitive processes.
- (f) Scientists and children use the same cognitive processes.

A quick glance at the theses reveals that some make different explanatory claims than others. Rather than taking up all of these particular differences, I focus on the general considerations that lay behind them. First, I will clear up a few ambiguities that arise from my expression of Gopnik and Meltzoff's views in the form of the above theses.

I said above that, prima facie, scientists and children have different cognitive processes. This claim is based on the fact that scientists are adults and are likely to have learned a great deal since they were children, for instance, how to solve differential equations. The issue turns on whether there can be an empirical demonstration that distinguishes between the application of a particular cognitive process in different situations or contexts and the application of different cognitive processes. I have a view of cognition as mental processing of all kinds, including visual processing, language comprehension and production, doing calculus, solving everyday problems and solving disciplinary specific scientific problems. So for example, on my view, there may be two distinct cognitive processes involved in the apprehension of an attractive geometrical shape and the comprehension of a graph, even though both processes are clearly driven by some application of the visual system. The relation articulated in thesis (f) above is therefore one that is open to further empirical scrutiny on my view. There is also a conceptual point at stake here, which is the general problem of the differentiation of cognitive processes. The extent to which "the same" process is used in various situations can be interpreted in several ways. My take on this is that individuals can share elements of visual processing and lack other cognitive processes that are dependent on visual processing. This approach implies a fineness of grain in distinguishing cognitive processes that is not generally accepted in cognitive science. In contrast one might say that cognitive processes are more coarse-grained, consisting in such things as processing complex visual images, mental modeling, or schema induction. But this discussion leads away from the specific issue of this paper.[5]

A further ambiguity is presented in my thesis (e). Thesis (e) could imply a mistaken comparison of science, which is a body of knowledge, and children, who are knowledge developers. In other words I am foisting a mismatch of process and product on Gopnik and Meltzoff in claiming that they hold thesis (e). One way of adjusting for this could be to restate (e) as (e′). Scientific knowledge and the knowledge children acquire during development are produced using the same cognitive processes. This restatement still seems problematic by my lights. Briefly, scientific knowledge, considered as a product, is a somewhat abstract concept that refers to more or less all the results of successful scientific practice over time. This concept is not easily accommodated into the model of the results of any individual's knowledge acquisition. (See Bishop and Downes for more on this point.)

Now let us return to more general considerations that underlie the above theses. If we refer to our definitions from biology, we can see that children's and scientists' development are instances of ontogenetic processes, where science more closely resembles a phylogenetic process. Each of the individuals involved in science has an individual developmental history and the history of science records, among other things, the cognitive products of these individuals. This claim that individual scientist's development correlates with ontogeny and the history of science with phylogeny is made in numerous places (see, e.g., Campbell 1982, and Toulmin 1981).

Gopnik and Meltzoff also appeal to analogies with biological development to support their view (see also Gopnik 1996a). They appeal to horticulture to provide complex analogical support for their position. If this appeal is to provide support for their position, we need to examine it carefully. I intend to do so guided by the distinctions introduced above from biology.

Gopnik and Meltzoff begin by introducing the work of horticulturalists who take basic mechanisms of species change and put them to work to serve particular cultural ends, producing flowers that fit with particular cultural conceptions of how flowers should look. They then draw

5. This paragraph and the one following were developed in response to some helpful comments by an anonymous referee. As my discussion indicates, the investigation of scientific cognition reopens numerous theoretical debates in cognitive science generally, and Gopnik and Meltzoff and other developmental psychologists point to fruitful ways of approaching these debates.

the analogy that science takes particular "natural mechanisms of conceptual change" and puts them to use in a particular way (GM, 21). So the way we should understand the scientific case is by reference to the more familiar biological case. A close look at the relevant biology reveals some interesting difficulties with the application of their analogies.

Artificial selection in breeding is the model Darwin took for natural selection. Darwin's view was that the production of variation through artificial hybridization experiments was an artificial version of nature's own hybridization experiments. Both situations involve accounting for phylogeny. We account for speciation in terms of natural selection working on naturally produced variation and we account for hybridization in terms of artificial selection. So Gopnik and Meltzoff are correct to say that "the basic facts of mutation, inheritance, and selection are the same [in plant breeding and natural plant speciation] and at a deeper level, it is these facts that explain why the flowers have the traits they do" (GM, 21). However, Darwin did not take artificial selection or natural selection to directly explain facts about individual development. As I outlined above, basic facts about mutation, selection, and so on, account for why organisms have the traits they do in successive generations, but different explanatory mechanisms are required to account for the production of those traits in any one particular organism in a particular generation. Mendel and Darwin did indeed recognize common underlying natural mechanisms to natural and artificial selection but they did not claim that these same mechanisms explained individual development. So Gopnik and Meltzoff's extension of the analogy to make a point about scientific development is undermined by the conflation of ontogeny and phylogeny. If I am right that children's development is an ontogenetic process and scientific development is a phylogenetic one, then Gopnik and Meltzoff can uncontroversially compare artificial and natural selection, but not childrens' development and scientific development.

What I have said so far here hinges on analogies or disanalogies with biology. Gopnik and Meltzoff's appeal to the above analogy in support of their view makes them look like recapitulationists. They appear to believe that one mechanism explains both ontogeny and phylogeny, as did Haeckel. Of course it could still be argued that although recapitulationism is false in biology, there could be a recapitulationist relation between children's and scientific development for completely independent reasons. My view is that if this is the reply, then biology should have been left out of the picture altogether. If biology is invoked to defend the view, I believe that ontogeny and phylogeny should be kept straight and Gopnik and Meltzoff should make it clear that they understand that recapitulationism is not available as a resource from contemporary biology. If biology is to be left out of the picture, then there must be independent grounds for a recapitulationist account of children's development. I turn to this issue now.

Gopnik claims (pers. comm.) that she starts from the empirical observation that children's development and scientific development are similar processes. But this is not an uncontroversial empirical observation, as many observers of scientific development fail to make the same observation as Gopnik. Once the similarity has been observed, the account goes, a mechanism must be provided to explain it. It is at this point that there are difficulties with Gopnik and Meltzoff's view. The similarity claim is not so much an empirical observation but a specific theory-laden point. It appears that rather than discovering a mechanism underlying two similar processes, Gopnik and Meltzoff have viewed two different processes from one particular perspective.

As we saw earlier in the paper, Gopnik and Meltzoff rely on an idealized account of scientific development as a procession of theories confronting evidence. Scientific cognition, on this view, consists in the operations that produce this parade of theories. Once we accept this view then it is easier to propose that children's cognitive development is similar to scientific development. Rather than contributing an empirically-based account of scientific development derived from developmental psychology, Gopnik and Meltzoff appear to superimpose a standard philosophical view about scientific development and theory change on children's cognitive development. Rather than discovering a "mechanism" that is common to two processes, they superimpose an idealized view of one process, scientific development, onto empirical results revealed from studying the other, children's development.

From the perspective advanced so far, the idea that scientific development provides a model for studying children's development is a recapitulationist idea. In nineteenth-century evolutionary biology, the fact that there were apparent overlapping stages in ontogeny and phylogeny led people to look for a common mechanism for both processes. To view children's development using the model of scientific development is also a recapitulationist move. The two processes are not the same; thesis e., that children and science use the same cognitive processes, is not prima facie correct. Further, defending such a claim requires more empirical support than any cognitive psychologists have yet provided.

In the final section I sketch a view of scientific development that is consistent with Gopnik and Meltzoff's aims in acknowledging the need for an account of the role of cognitive processes of individual scientists. First, I turn to relations between scientific cognition, history of science, and evolution.

5. How Good Are Our Cognitive Processes? For Gopnik and Meltzoff, children or scientists getting things wrong is the unusual case. Children learn a correct picture of the world and the objects around them and scientists get things right more often than not. This view derives from their belief, presented above, that cognition is a process, or set of processes, selected for by evolution to represent the world correctly. As I mentioned earlier, this view about cognition getting things right is intimately connected with the theory-formation theory, because, according to Gopnik and Meltzoff, the cognitive processes that enable children to be such cognitive overachievers are exactly those used by scientists. There are two components of this view that demand further scrutiny: first, we can ask whether cognition and veridical or "truth-tropic" cognition are the same; and second, we will need to spell out and examine the claim that "truth-tropic" cognition has been selected for by evolution. Let us take these issues one at a time.

There is a tendency in much cognitive science to set out with the aim of producing a naturalistic or descriptive hypothesis and end up with a normative one. Rather than presenting hypotheses about actual mental processing, we often present hypotheses about optimal mental processing or how to be rational. Philosophers find this hard to avoid but there is no lack of arguments that warns against this tendency. An example of this difficulty arises when accounting for the development of science in terms of individual scientists' cognition. What I call the "Priestley problem" will help illustrate this point.

If we grossly oversimplify the history of science, Joseph Priestley was wrong. He held the phlogiston theory of combustion, rather than the oxygen theory, which we now know is correct. On the other hand most philosophers of science would want to grant Priestley the recognition of being a good scientist. His cognitive practices were in many ways exemplary. He used the experimental method to great effect, being the first to isolate what he thought was de-phlogisticated air. How can he both be a good scientist and wrong?[6] On Gopnik and Meltzoff's view, getting it right is characteristic of science. Does this mean that Priestley was dysfunctional and that he used bad cognitive processes? If this is the implication, then much of the history of science has been produced by non-veridical cognitive processes. And on this view most important scientists have been cognitively defective in one way or other: Einstein did not believe the fundamental tenets of quantum the-

6. Kitcher (1993, 96–101) has a good discussion of Priestley that focuses more on aspects of the reference of scientific terms, but reflects some of my concerns here. Giere (1988) refers to Priestley as one of the history of science's great "holdouts."

ory; Newton was wrong about motion at high speeds and the nature of gravity; Darwin was wrong about pangenes.

The claim that science characteristically gets things right may be correct as a statement about science, construed as the collection of practices, combined throughout history to investigate the nature of the world and the structure of its laws. But it does not necessarily follow that the success of science depends on individual scientists having truth-tropic cognitive abilities. If Gopnik and Meltzoff intend the claim that Priestley helped the whole process of scientific investigation get closer to the truth, then this would be a claim about the process of science and not Priestley's individual contribution. This point illustrates the difference between theses (a) and (b) above.

This discussion leads to the more general question of whether a cognitive science of science need presuppose that cognition is veridical or truth-tropic. One suggestion is that cognitive science of science, construed as the study of individual scientists as cognitive agents, can rely on the more neutral view that cognition is mental processing. For example, we could assume with Peter Godfrey-Smith (1996), among others, that cognition is "a basic apparatus that makes possible perception, the formation of belief-like states, the interaction of these states with motivational states such as needs and desires, and the production of behavior" (22). On this account, cognitive science would be the empirical study of just what that processing consists in and cognitive science of science the empirical study of the particular mental processes that are used in science. Then it is empirically contingent that apparently non-truth-tropic cognitive processes are instrumental in the discovery of successful scientific theories. Miriam Solomon (1992) argues that there is at least one example of the use of non-truth-tropic cognitive mechanisms in the history of successful science in her discussion of the successful plate-tectonics revolution in geology.

Several of the proponents of this more neutral and pragmatic view of cognition have also produced convincing arguments against the validity of the second component of Gopnik and Meltzoff's view of veridical cognition: that it was selected for by evolution.

Gopnik and Meltzoff clearly state that veridical cognition is selected for and also claim that this is an assumption of cognitive science. There are several arguments against this view.[7] The upshot of these discussions is that truth is separable from cognitive success and that truth-tropic cognition is not likely to be selected for. Here is one such ar-

7. Stephen Stich (1990) presents some of them and Edward Stein (1996) reworks them with some additions. Godfrey-Smith (1996) provides a useful discussion of the notion of correspondence and its role in biologically based accounts of cognition.

gument against this particular selection process: An organism may represent either false positives or false negatives. For an omnivore in a "gastronomically heterogeneous environment" (Stich 1990, 62), false positives are cheap. If you think that a certain food is poisonous and hence do not eat it, then you are fine. False negatives are costly; if you believe that the food is not poisonous and hence eat it, you could be poisoned and die. A very cautious risk aversive strategy might be more fitness enhancing and hence selected for, despite being unreliable and prone to representing falsehoods. As Stich points out, "natural selection does not care about truth; it cares about reproductive success" and from this perspective "it is often better to be safe (and wrong) than sorry" (1990, 62). The take-home message here is that we can separate evolutionary issues from truth acquisition, while still discussing the biological role of cognition. In my final section, I will briefly address the question of whether we can have a view of scientific development that contains an evolutionary component and attends to individual scientists' cognition.

6. A Glimpse of an Alternative Approach to Scientific Development. Given that I argue against key components of Gopnik and Meltzoff's view of scientific development and have some reservations about their presuppositions about the nature and origin of cognition, why have I claimed that I agree with some of their criticisms and that I endorse some of their methods? Gopnik and Meltzoff are right in their view that understanding individual cognition is an important component of philosophy of science. So I agree with their use of this point to motivate a rejection of rational reconstructivist philosophy of science. But as I point out, while they claim that they reject a traditional philosophy of science approach, that approach comes back to haunt them. Their account may also be understood as an evolutionary approach to scientific development as they invoke evolution as a mechanism that produces the cognitive processes required for science. I have argued that some problems face this particular evolutionary approach. But this leaves the question of whether some kind of an evolutionary account of scientific development may be correct. I now turn to this question.

Scientists are agents with varying cognitive capacities (cf. Giere 1988, Stich 1990, Kitcher 1993), many of which develop during late adolescence and adulthood. Later cognitive development is very much a product of environment, such as scientific education and scientific culture. As I argued above, the fact that all humans have the basic capacity to process complex visual images does not mean we do not have to teach them to understand graphs. Even among the extremely small subset of the world's population who are professional scientists, there is a huge amount of cognitive diversity. This diversity ranges from variation in memory capacities to varying abilities at mathematics.

Chronicling scientific development is a post hoc procedure that collects together scientists' achievements as they are presented in journals and books and embodied in new instrumentation. There is no such thing as the development of science per se, but there is the accumulation of instruments, theoretical techniques, experimental techniques and so on, which, in each of the specific areas for which they are designed, provide us with more predictive ability, control and information (cf. Kuhn 1970).

What is the relation between the stories about cognitive diversity among individual scientists and the development of science? Along with Kitcher (1993, 71–72), I propose that this kind of cognitive diversity is an important contributor to scientific development. If scientific development is a kind of evolutionary process, and I think at the present state of our knowledge we can only claim that it is analogous to evolution, then the process requires diversity or variation. Scientific development is evolutionary only in the sense that it is moved along by operations on concepts, theories, images, instruments, and objects that are already available to scientists, rather than driven by some predetermined goal (cf. Kuhn 1970). The relevant operations are carried out by individuals with varied cognitive capacities. The result of the process is the production of new theories with varying successes at prediction and control. The relevant variation is in cognitive capacities of individual scientists and in instruments, concepts, and theories. The theories that are successful relative to scientific epistemic standards "survive" (cf. Kitcher 1993, Hull 1988).

My point in introducing this evolutionary approach to understanding scientific development here is to give a sense of an alternative possibility to a "literal" evolutionary model of scientific development. Edward Stein uses the term "literal" (1996, 206) to distinguish approaches that claim that science is a product of evolution or directly caused by evolution. On Stein's account, Gopnik and Meltzoff's view of scientific development is a literal evolutionary model as they claim that the truth-detection mechanisms used by scientists are selected for. In contrast with Gopnik and Meltzoff's account, the view I have sketched here does not require that cognition is veridical and selected for as such. Further, the account pointed to here includes an important role for scientists as individual cognizers, but steers clear of recapitulationism.

Problems confronting the cognitive science of science will not be solved by working out the details of evolutionary accounts of scientific development; rather they will be more productively confronted by advances in empirical studies of cognition. Gopnik and Meltzoff, along with others, have forced us to acknowledge a role for developmental psychology in this enterprise. One promising area for further empirical study will involve spelling out the details of the claim that adults and children use the same cognitive processes.

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